

Preface

This book focuses on the numerical methods of the two-phase fluid flow and the displacement in fractured vuggy porous carbonate reservoirs as well as quantitative approaches for describing such multi-scale physical processes. The book is intended to complement the existing literature by presenting new advances and updated developments in the two-phase fluid flow in fractured porous media, especially for fractured vuggy carbonate reservoirs. The material of this book is based primarily on (1) a series of peer-reviewed papers, published by our research group, (2) the technical reports that we have done during the research projects, including National Program on Key Basic Research Project (973 Program) and National Key Technologies R & D Program of China, and (3) the course notes that we used to teach undergraduate and graduate courses on advanced multiphase fluid flow in porous media at the China University of Petroleum (East China). The publications that this book is based on are related to the research on the subject of two-phase fluid flows in fractured vuggy porous media, which we have carried out or been involved with since the late 2000s.

This book can be used as a textbook or reference for senior undergraduate and graduate students in petroleum engineering, hydrogeology or groundwater hydrology, soil sciences, and other related engineering fields, such as civil and environmental engineering. It can also serve as a reference book for petroleum reservoir engineers, and other engineers and scientists working in the area of flow and transport in fractured porous media, especially in fractured karstic/vuggy media.

The contents of the book are organized to cover fundamentals of two-phase fluid flow in fractured and fractured vuggy porous media based on the discrete medium concepts and its corresponding applications. It discussed the multi-physical processes and principles governing coupling two-phase free flow and porous flow by using Navier–Stokes equations and Darcy’s law. The book starts from the discrete fracture model, and then various numerical approaches are introduced to model the immiscible two-phase fluid flow in fractured reservoirs. Specifically, we proposed the discrete fracture-vug network model (DFVN) to analyze immiscible two-phase

flow in fractured vuggy porous media. The DFVN model is an extension of discrete fracture model for fractured vuggy porous media. Based on these discrete models, an efficient equivalent medium numerical simulation is also developed and presented, which is more suitable for practical applications. In addition, the book reviews the hybrid and multi-scale concepts, approaches, and developments for modeling two-phase flow in fractured vuggy porous media. In an effort to include the new developments, the book also presents mathematical formulations and numerical modeling approaches for two-phase flow by using multi-scale finite element methods.

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Fractured Vuggy Carbonate Reservoir Simulation

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2017, XI, 245 p. 152 illus., 82 illus. in color., Hardcover

ISBN: 978-3-662-55031-1